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EDITORIAL NOTES

AMERICAN FACTS—

FROM thoughts of restrictions which for a long time now have necessarily been imposed on every grade of production designed for civilian use in this country, it is interesting to turn to what is happening in the same direction in America; our remarks are confined to two aspects of production—that of domestic gas cooking and heating appliances and that of toluene. In May last the War Production Board for the first time adopted the principle of concentration of production, ordering an end to the manufacture of domestic cooking appliances by large producers after July 31, but permitting the production of a limited number of simplified and light-weight models by smaller companies for civilian use. The Order, in brief, made it essential for the larger firms to concentrate on war production, leaving proved and sanctioned civilian needs to be met by the smaller firms. A feature of the Order was the designation of a number of "labour shortage areas"—actually, 39 in fifteen different states. Any firm—large or small—located in these areas had to discontinue production of gas cooking and heating appliances; but, while the Order also covers oil and solid fuel appliances, it does not cover electric appliances. At the moment we have insufficient information to offer any explanation of what appears to be a peculiar demarcation between electricity and all the other suppliers of fuel for domestic purposes. In addition to the major limitations we have mentioned, no person is now permitted to manufacture any domestic cooking appliances (electric apparatus excluded) except "permitted types"; and simplification and reduction in weight is ordered for each permitted type or unit. Again, no manufacturer is allowed to produce more than one model of "permitted type" gas cooker, and "permitted" cookers have to be manufactured to comply with the performance and safety requirements set forth in a new American emergency standard. Use of any iron or steel in the production of cover tops or lids for domestic cookers, which, of course, includes the assembly of any cooker equipped with such covers, is prohibited. This requirement that all firms in labour shortage areas discontinue production, with the cessation of cooking and heating appliance manufacture by the larger companies, is expected to release about 25,000 workers for war industry. The industry as a whole normally employs 35,000 people. Another Order releases the sale to householders of cooking and heating stoves and water heaters where no other equipment for these purposes is available, and—this will be noted—facilitates the conversion of gas burning equipment to the use of coal.

The Toluene Order, designed to provide an additional 200,000 gallons of toluene per month, directs every person who carbonizes coal to operate his plant so that the maximum amount of toluene will be produced. Every such person is forbidden to sell, use, or deliver any oils containing toluene until the maximum amount of toluene has been extracted or unless the purchaser is equipped to extract the toluene himself, in which respect it is comparable with the Order which we have for long had in force in this country.

—AND OPINION

IT is interesting, too, to compare and contrast current opinion in America and this country; and once again we will confine ourselves at the moment to two aspects. First, the position post-war of gas *vis-à-vis* other forms of fuel, including electricity. We have the new Ministry of Fuel and Power; consensus of opinion is towards co-ordination of all fuels, having coal processing as the starting point. The aim before us is, we think, a workable and comprehensive fuel scheme, each fuel being used in the sphere best fitted for it, with the interests of the public as the basic consideration. At the June meeting of The Institution of Gas Engineers one of the contributors to the discussion urged the dropping of the mutual assault and battery between gas and electricity. Electricity, he argued, has a large off-peak capacity which in the interest of the community ought to be used. "Do we expect, or wish," he added, "to abolish the electrical industry? By resisting its development we have suffered where it hurts us most—the cooking load. Surely we can co-operate in a national plan based on true costs of supply." Another contributor remarked that, while unilateral disarmament may be as senseless in industry as it has proved politically, if a sane national fuel policy is to be adopted, then it is necessary for the gas and electricity industries to agree upon a division of the energy requirements in private houses, which in the long run, and on the assumption that both are required, will give the most satisfactory financial results—satisfactory from the point of view of return on capital expended and from the point of view of the consumer's pocket.

Contrast the foregoing train of thought with the opinion expressed in a memorandum written a short time ago by an executive of a large gas appliance manufacturing company in America. We do not know to what extent his picturesque remarks interpret the general tone of thought of the American Gas Industry, but time and again during the past year, and particularly during recent months, we have come across in the American technical Press Papers, Addresses, and speeches containing similar sentiments. The view of the executive mentioned is that after the war abrupt cessation of the tremendous war materials programme will affect very seriously the loads of both the gas and the electricity industries. The Gas Industry will stand to lose its war-materials heat-treatment load (and one only of the many huge gas-fired industrial furnaces uses as much gas as 30,000 cookers), a great deal of the heating load of recently built factories, and much of the general load due to disruption of employment. On the other hand, he thinks the electricity industry will be in an even worse plight, for, in addition to the losses in the power and lighting loads, it will lose much of the miscellaneous load, such as welding, and so on. He is not a little pessimistic; he also suffers no mental reservations, for the foregoing loss of load "will happen more certainly than the proverbial rising of the sun." When there will start "one of the wildest scrambles for substitute loads that America has ever seen." And in the memorandum he continued that much of the scramble will resolve itself into competitive fighting for loads common to both gas and electricity—cooking, water heating, and refrigeration. In the past there has, he gently remarked, been some so-called fighting for that load between the two utilities, but, in retrospect, that fighting will seem to have been exceedingly tame—"almost like the gentle slaps of a two-year old baby. In contrast, the cat-and-dog fight which is to come in the post-war period for that domestic load will be more like the fight between the wildest of wild cats and the maddest of mad dogs." What a picture! Wisdom, he concluded, lies in building-up ammunition for the merchandizing battle to come. It is with relief and with faith in a better fuel organization that we reflect on the spirit abroad in Great Britain aiming at a scheme whereby each fuel will be used in the sphere best fitted for it—with, we repeat, the interests of the public as the basic consideration.

From contemplation of this complete variance of viewpoint, we change to a phase of post-war gas service where we find a large measure of agreement between opinions expressed in this country and views put forward in some quarters in the States. The possibilities of standardization have for long been the subject

of discussion in this country, and since the war with special reference to the time when the war is over. In regions throughout this country the hope is held—and, we trust, not vainly—that it may be possible to have a cheap standard cooker with interchangeable parts, one maker with another—a cooker which would not compete in what we may term the field of the better-class cooker. It has been suggested that appliance manufacturers should provide a "good general line" (this description was used at a meeting of the Institution) as well as high-grade appliances. A further suggestion is that the requirements of the public would be served by having not more than two designs of each type of appliance, each design having similar ranges of size and efficiency, but one manufactured for sale as cheaply as possible, the other having cost as a secondary consideration.

This idea of having a satisfactory and efficient range of appliances of low cost finds a counterpart in an interesting article by an American gas consultant recently published in the American Press. His view is that, up to the present, gas equipment has been available between extreme limits—best and worst. That a very large majority of consumers are using "worst" appliances, and that there is comparatively little equipment available between the best and the worst which gives much better consumer satisfaction than the worst. Has the fact that our best equipment is so good caused us to neglect the mass market? Have we adequately covered the market with appliances which are within the ability of our consumers to pay? The Author feels sure that we should study and cater for the demand for "intermediate" appliances, and regarding the development of "intermediate" types, he places the responsibility on gas undertakings themselves, in concerted action, rather than on the makers of the appliances. His argument is interesting. Condensed, it is on these lines: Gas undertakings have to continue to sell gas. The manufacturers of appliances do not need to continue, now we are at war, the production of gas-using equipment. Certain manufacturing firms may go out of business altogether as far as the Gas Industry's requirements are concerned. Others, more closely dependent on the Industry in the past, will in any event alter their production to war needs. After the war, re-conversion of their plants will be necessary. Re-conversion will be effected only if the Gas Industry is capable of offering opportunities and a promising field; otherwise, without this lead, many may well say to themselves that they might with greater justification and more chance of profit change over their works and factories to the production of electrical equipment, or button-hooks, or merry-go-rounds. If this happens, it will be the Gas Industry which will suffer, not the manufacturers; hence the Industry collectively must shoulder most of the burden of sponsoring new developments.

We think that the planners of the post-war Gas Industry of Great Britain could do better than dismiss the foregoing line of reasoning as being too remote to warrant consideration.

EVALUATING SILICA REFRACTORIES

IN view of the present shortage of labour and materials, particular interest attaches to a description which we publish in our columns to-day of a microscopic method of evaluating silica refractories. The method, which has been applied with success to routine control, has been developed in the laboratories of the Gas Light and Coke Company, and was the subject of a Paper to the London & Southern District Junior Gas Association by Mr. P. F. F. Clephane. The primary considerations for the stability of a silica retort setting in service are the degree of conversion from quartz into cristobalite and tridymite which has been achieved in the kilning of the bricks, shapes, and segments, and the kind and proportion of the bonding material used. These characteristics can be not only rapidly but accurately assessed by the use of a medium-power microscope fitted with rotating-stage, sub-stage condenser, polarizer, and analyzer.

As we have mentioned, the method is rapid and accurate. An inexperienced operator can (with white light and filters) detect a difference of 0.003 in refractive index; after a little experience, differences of 0.001 are quite plain. The difference between quartz and cristobalite is 0.063, so that results within 2% may be expected. The technique is easily acquired. It gives the examiner a visual picture of the condition of the refractory examined and protects the manufacturer from the unjust condemnation of his goods as "underfired" should the standard after-expansion test show a permanent expansion, due to stresses exerted by the α–β cristobalite inversion, which would be unlikely to occur if the brick or segment was built into a setting and so was subject to external restraint. In this connexion we may well quote from the section of the 32nd Report of the Refractory Materials Joint Committee of the Gas Research Board dealing with an investigation of the permanent expansion of silica products containing cristobalite. "A high after-expansion at 1,450°C. is generally ascribed to the conversion of quartz to cristobalite, and there is every justification for this assumption should there be a corresponding change in true specific gravity. Specimens have, however, been reported from time to time which have shown a higher after-expansion than was warranted by the change in specific gravity, and in those cases it is suggested that the possibility of permanent expansion consequent upon the cristobalite inversion should be borne in mind."

With the microscope, employing surface scratchings as test material, it is possible to study a representative number of specimens from any consignment without damaging them for subsequent use—a virtue which, as the Author points out, is possessed by no other method of examination so far advanced. He states, too, that while it is safe to pass material giving a satisfactory showing on microscopic examination, where purchase is made under contract based on I.G.E. Specifications, doubtful specimens must be submitted to further tests before rejection. Actually, in the case of the Gas Light and Coke Company, the purchase contract now includes this clause: "The Company will submit the silica material to microscopic examination as evidence of the degree of conversion of quartz necessary to comply with the after-expansion requirements of the I.G.E. Specification. Should such observations indicate that the material would fail to comply with the I.G.E. Specification, the degree to which it is judged to fail shall be accepted by the contractor."

The Paper was concerned solely with the microscopic examination of refractory materials, but there are sure to be found other uses for the method in the rapid determination of refractive index in the identification of various materials brought into the laboratory for investigation.

COAL QUALITY

RECENTLY the Minister of Fuel and Power stated publicly that it was quite impracticable to supply the correct grades of coal for particular industrial purposes, though he spoke of efforts being made to minimize difficulties. At the time we expressed the hope that these efforts would achieve something in the way of directing the proper grades of coal into the channels in which the best use of them can be made in the prosecution of the war, having in mind the difference between steam coal and gas coal, and thinking of the transport involved in conveying the wrong material to the right place. However, a note still more recently issued by the Minister of Fuel and Power (see last week's "JOURNAL," p. 240) emphasized the Government's request that all industrial managements should, in the national interest, make arrangements at once to accept at least a proportion of their coal supplies in a lower grade than those normally supplied —in other words, to use fuel of an inferior nature not properly suited to their plant and equipment.

While we are doing our best—we shall, of course, do our best —with the wrong material, we can have consolation in the knowledge that in one vital direction the right coal is being supplied for its destined purpose. We feel we ought to record this. It concerns shipping—the use of coal at sea amid hazard. Variations in coal quality were always noted in peacetime. To-day

they are obviously of extreme importance. Upon the qualities of the coal used depends the ability of steamships to maintain their stations in convoys, and on that in turn depends largely the safety of life and property. Another question is the need at sea to reduce smoke to a minimum. These and other points directly bearing on the suitability of particular types of coal for the purpose have been studied to good effect. The descriptions are carefully classified; samples of all supplies, the *Times* stated a few days ago, are constantly taken by inspectors at the ports and analyzed. This system of investigation applies not only to bunkers shipped at United Kingdom ports, but also to shipments to coaling stations abroad for the use of vessels in the service of the United Nations. The system devised for ensuring that only the most suitable coal is used now appears to have reached a high standard. Nothing but the very best is the rule, and one can be thankful for this.

Some of the considerations are peculiar to shipping. Yet, surely, in other phases of the war effort economy in coal consumption and much higher efficiencies could be secured by tackling with more persistence this fundamental problem of allocating coal scientifically.

Gas Special Orders

The Gas (Special Orders) Rules, 1941 (S.R. & O. 1159, 1941), made by the Board of Trade in regard to applications for Special Orders under the Gas Regulation Act, 1920, are revoked by the foregoing Rules made by the Minister of Fuel and Power which came into force on Aug. 11. Apart from minor and drafting alterations, the new Rules provide that applicants may be exempted by the Minister in existing circumstances from certain of the requirements of the Rules—*e.g.*, advertisement of the application.

Gas Economy and Two-Part Tariff

It has been suggested in some quarters that householders who buy gas or electricity on the two-part tariff will be less likely to save fuel than householders who are on the flat rate, because even if they do economize they still have to pay the standing charge. Why should householders, the argument runs, economize to benefit the gas undertaking's pocket? As far as the Gas Light and Coke Company is concerned, not one of its consumers who is on the two-part tariff need be penalized by economizing in gas. In September, 1938, it was announced that if at the end of twelve months any consumer of the Company should find that his gas under the two-part tariff had cost him more than it would have done on the flat rate, the Company would, on application from the consumer within 12 months, refund the difference; this arrangement still holds good. In addition to this, the Gas Light and Coke Company, in its anxiety to give every possible aid to the Government in the effort to save more fuel for the factories, attaches a special sticker to the account of every two-part tariff consumer, drawing attention to the need for fuel economy, and also to the fact that he is at liberty to revert to the flat rate of charge if he so desires.

Personal

Mr. H. E. AIREY has been appointed to the Gas Light & Coke Company's Gas Research Fellowship at the Imperial College of Science and Technology as from Oct. 1 next.

* * *

Mr. LEOPOLD FRIEDMAN, Chief Engineer and Director of Development and Research, Ascot Gas Water Heaters, Ltd., has been appointed General Manager of the firm.

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Many will be interested to hear of a message received by a friend in this country from Mr. R. G. LUXON, of Guernsey, who is now interned at Danzig. He reports himself fit and well, and looking forward to seeing friends on this side again.

National Gas Council

A meeting of the Central Executive Board of the Council was held on Aug. 11. In the absence of Sir David Milne-Watson, the Chair was taken by Mr. Frank Jones, J.P. (Vice-Chairman).

It was stated that the representation of the Institution upon the Board would continue as at present for the year June, 1942, to June, 1943, namely: Mr. E. V. Evans, O.B.E. (President), Mr. John Terrace (Honorary Secretary), Sir Frederick J. West, C.B.E., J.P. (Immediate Past-President), and Mr. George Dixon, B.Eng. (Past-President).

A report was received with regard to coal supplies, and it was stated that a full report had been made to the Council of the Conjoint Conference with regard to the coal position generally. The question of price together with the machinery for price-fixation had been remitted to the Coal Committee of the Conference.

With regard to demurrage, the Council of the Conference had agreed that the Demurrage Committee should be enlarged with the object of facilitating a settlement with the Railway Companies.

It was reported that undertakings finding it necessary to increase the price of gas to cover the additional costs due to the recent flat rate increase of 3s. per ton on coal and the recent advance of 3s. 9d. per week in wages, had been advised to make application to the Ministry of Fuel for permission to do so, on the lines of the circular letter issued by the Council to its members on July 30.

At a meeting of the Council of the Conjoint Conference on July 24 the question of the increasing burden of local rates on mains in rural areas was remitted to the Rating Committee of the Conference. The matter of the use of devastated areas for military exercises was reported as one of common interest, in order that utilities might be forewarned.

The recommendations of the Committee of the Council which had been appointed to consider the question of surplus coke-oven gas were laid before the Board, and it was stated that the Ministry of Fuel was investigating the whole subject.

It was stated that the Council of the Conjoint Conference had given their whole-hearted support to the National Fuel Economy Campaign. It was reported that the Ministry of Fuel and Power had set up (i) a Publicity Committee, and (ii) a Domestic Fuel Planning Committee, on both of which the Gas Industry was represented.

Mr. E. V. Evans, Vice-Chairman of the National Gas and Electricity Committee, reported the proceedings of the Committee since the last meeting of the Board, and a letter which the National Committee proposed to despatch to all gas and electricity undertakings regarding particulars of consumption was approved. The following additional representatives were appointed to represent the gas interests on the National Gas and Electricity Committee—namely, Mr. Hunter Rioch, Mr. S. E. Whitehead, and Mr. F. C. Briggs.

The appointment of a special committee on Transport Reconstruction was reported to have been made by the Federation of British Industries, and it was stated that the Council had been invited to nominate a member to serve on that Committee. The Board appointed Mr. Ogilvie as their representative on this Committee.

It was agreed that the next meeting of the Board should take place on Tuesday, Sept. 8.

Standard Gas Cylinders

The British Standards Institution has recently issued a further specification in the series of British Standards for Steel Cylinders for the storage and transport of gases. The present specification relates to manganese steel gas cylinders for atmospheric gases and is based on Exemption Orders Nos. 16 and 21 to the Gas Cylinders Conveyance Regulations of 1931.

The specification lays down the quality and composition of the steel and its heat treatment, requirements relating to the thickness of the cylinder walls, and a series of mechanical and pressure tests.

Copies of this specification B.S. 1045 can be obtained from the British Standards Institution, 28, Victoria Street, S.W. 1, price 2s., 2s. 3d. post free.

The Year's Working of the Hawick Gas Company, Ltd., showed a profit of £1,923, and a dividend of 4%, free of tax, has been declared.

Electrolux Ltd. will be able to supply reasonable quantities of L.55 and L.750 cabinets to undertakings for delivery in about 3–4 weeks. Every order must be for a priority customer and must be accompanied by an "M" form.

The Tottenham and District Gas Company has declared the following dividends: Ordinary Stock 2½% actual, 5% Preference Stock 2½% actual, 5½% Preference Stock 2¾% actual, all in respect of the half-year ended June 30, and all less income-tax.

A Meeting of the Emergency Panel of the Council of the Gas Research Board will be held at Gas Industry House on Aug. 25, at 11 a.m. The principal business of this meeting will be to discuss the closer association of the Gas Research Board with the Department of Scientific and Industrial Research.

The Gallantry of Mr. James Williams, an employee of the Leamington Priors Gas Company, who on April 2 rescued a child from drowning, was recognized officially on Aug. 10, when the Mayor presented him with a Testimonial on Parchment awarded by the Royal Humane Society.

The fact that goods made of raw materials in short supply owing to war conditions are advertised in the "Journal" should not be taken as an indication that they are necessarily available for export.

THE GAS INDUSTRY OF THE FUTURE.—2.

EXAMPLES OF REGIONALIZATION IN THE WATER INDUSTRY

The Gas Industry has a great future, but it is generally agreed that it must face radical changes; that it must form opinion within its ranks; and that it must work out its own salvation—or accept the consequences of neglect. To help the Industry to decide which way it wants to go the "JOURNAL" has studied the experiences of other public utility services which have been confronted with similar problems in recent years. The following is the second of a series of articles in which an effort is made impartially to review some of the principal schemes of rationalization in the other industries, with their possible lessons for the Gas Industry. The series covers water supply, passenger transport, the main line railways, port and dock authorities, broadcasting, and the electricity industry.

WATER supply is unique among the public services in that Parliament has imposed on every local authority a statutory obligation to secure a "sufficient supply of wholesome water" in its area, and for that reason the tendency has always been towards municipal administration. Wherever undertakings have changed hands they have invariably passed from company to municipal ownership, although there are many large and extremely efficient private companies in the industry. For many years, however, there has been a steady process of regionalization, the supreme example of which was the formation nearly 40 years ago of the Metropolitan Water Board, to which reference will be made later. The relative situations of the natural sources of supply and the centres of population and industry make it impracticable to define any uniform basis for dividing the country into areas, and there can be no question of a national water grid like the electricity grid, which would be a mere waste of time and money.

The chief trend has been towards the joining up of neighbouring undertakings, and there are now some 60 joint water authorities throughout the country. Grouping has taken various forms, the commonest of which is the joint board representing the complete amalgamation of undertakings responsible for conveying water from its source to the consumer. Other joint boards have been constituted solely for bulk supplies, the most noteworthy case being the Derwent Valley Water Board, which supplies water in bulk only for the densely populated areas of Sheffield, Derby, Leicester, and Nottingham, whose combined area of distribution is some 594 sq. miles, or about 18 sq. miles greater than that of the Metropolitan Water Board. A more recent and much smaller example of neighbourly co-operation on similar lines is the Cheltenham and Gloucester Joint Water Board, which affords bulk supplies to the separately constituted distributing undertakings in the Boroughs of Cheltenham and Gloucester.

Usual Type of Joint Board

Of the more usual type of joint board, which relieves numerous local authorities of the operational problems, if not of the legal liabilities, of water supply within their areas, three examples are worth noting—the Fylde Water Board, which serves Blackpool and several adjoining districts; the Irwell Valley Water Board, covering another group of towns in Lancashire; and the West Cheshire Water Board, serving a substantial slice of the county. The joint water board is a legally constituted water authority, the private companies absorbed in its formation being wound up, and the municipal undertakings in the area losing their separate identities, but it is one of the oddities of the existing law that the ultimate liability for supplying water remains on the shoulders of the local authority. For instance, in the extremely unlikely event of, say, the Fylde Water Board absconding with all its plant, the Blackpool Corporation would wake up one morning and find itself responsible for seeing that its ratepayers were provided with sufficient water to maintain health. When water undertakings are amalgamated there is usually compensation for abolition of office, based on the complete absorption of the assets and liabilities of the undertaking under powers conferred by general or special Act of Parliament, but it is found in practice that the increased efficiency and economy secured by the amalgamation more than covers the cost of such payments.

An alternative to the joint board is the joint water committee—a body appointed by two or more adjoining authorities to look after the interests of their separate undertakings and to facilitate such matters as technical supervision. As in the Gas Industry, a serious difficulty in the water industry is that of securing the highest technical skill for the management of the small undertaking, and regional co-operation, either by amalgamation, joint board, or joint committee, is the only solution. In many cases the local council's engineer and/or surveyor has to take charge of the waterworks, whether he has had any specialized training in that sphere or not. Many of them are doing a very fine job of work, and it is no reflection on any of them to say that the system cannot be regarded as universally satisfactory. In these days of specialists, the point is that if the undertaking can be made large enough to afford the services of a specially trained water engineer it will be to the advantage of both undertaking and consumer. In a village with 1,000 inhabitants living in some 250 houses, it may be impossible to collect a water rental of more than about £2 per house per annum, and as roughly half the income of the average water undertaking is swallowed up in rates and capital charges, the village waterworks is left with a total income of £250 a year—not enough to pay for routine labour, to say nothing of skilled supervision.

Supply Authorities

No one knows precisely how many water authorities are supplying water in Great Britain to-day. As already indicated, every local council is legally a water supply authority but not all of them supply water. Roughly there are 840 local authorities and joint boards, and 173 companies—a total of 1,013—supplying water in England and Wales under general or special statutory powers, and some 1,080 companies and persons supplying water without statutory powers. Over 95% of the population with piped supplies are served by 466 of the statutory undertakings, and the Metropolitan Water Board alone supplies nearly 20% of the population. Populous areas are covered by other large corporations, and it is computed that some 85 municipal and company undertakings provide piped supplies for three-quarters of the population. About a third of the country's water supplies are piped to consumers by the big water companies, some of which serve several million people. Thirty companies supply groups of 50,000 to 500,000, and at least 200 other bodies, municipal and company, supply communities of from 10,000 to 50,000, leaving something like 1,750 smaller concerns to cater for the remaining five million people in the country. Scotland has seven water boards, some of which cover areas as great (but by no means as populous) as that of the Metropolitan Water Board, and there are over 500 independent supply systems.

As part of the public health service, water supply is the concern of the Ministry of Health, and so far no separate Department has been charged with its administration, though there is a desire on the part of the industry for a distinct and specialized Water Department of an appropriate Ministry. The industry has its own national organizations, chief of which is the British Waterworks Association, whose Directory of 1,393 water undertakings is recognized as the official list, and whose members are responsible for over 95% of the piped supplies of the country.

Statutory Regional Committees

Some years before the war the Ministry of Health appointed a Central Advisory Water Committee and nine Regional Water Advisory Committees, the latter covering areas with a total population of 15 millions. The Central Advisory Water Committee studied the problems involved in the better co-ordination of the water supply industry, and far reaching proposals based on its recommendations were embodied in a Water Undertakings Bill, which would have superseded the present waterworks code. In consequence of the war, however, the new legislation, which might not have been generally acceptable without amendment, was indefinitely postponed, as also was a Water Supply Bill sponsored by Sir Reginald Clarry. The Committee recommended that when new water sources became necessary they should be selected and developed in the best interests of the community, with close consultation between all water interests before new sources were selected. The Committee also urged that regional planning on the lines of the nine existing regional committees should be extended, and that the committees should become statutory instead of voluntary.

One of the industry's most difficult problems is that of the rural areas, where the cost of affording piped supplies is prohibitive in the absence of some assured financial aid, and where villagers are content with the parish pump. The Supply of Water in Bulk Act, 1934, which empowered statutory undertakings to give and take supplies in bulk subject to the consent of the Minister of Health, did something towards breaking down the artificial boundaries of areas of water supply and the "dog in the manger" attitude of many county councils which had fought strenuously against water derived in one county being supplied outside the county boundary.

On the question of the ideal area for regional administration, the feeling in the industry is that, as planning will require not only a central planning authority but also regional or district planning authorities, the district planning areas should conform to watershed areas, and should not be restricted by boundaries of local government areas, since proper planning in what is really an economic sphere should be based on natural and not on artificial areas.

London's water supply was the first of the public utilities to be rationalized on a big scale, and despite the more recent formation of "public corporations" to deal with other services, the Metropolitan Water Board remains one of the largest municipal authorities in the world. Created under the Metropolis Water Act, 1902, the Board acquired at a total cost of £47,000,000 the undertakings of the eight water companies supplying water in Greater London at that time. The Board now supplies water in a statutory area of 576 sq. miles, covering the whole of the County of London and parts of Essex, Herts, Kent, Middlesex, and Surrey, with a population of eight millions, in addition to which it affords bulk supplies to several other authorities. In the last 40 years it has been necessary to increase the water storage by 400%, while the pipe mileage is about 42% more than in 1902. There are considerably more than 100 local authorities in the area, and the benefits of the Board are summed up in the following passage from the report of a Departmental Committee which inquired into its operations a few years ago : "Its wide and populous area has been supplied with a safe and constant supply of water; excellent arrangements have been made for securing the accurate and complete collection of its revenue, for managing its finances, and presenting its accounts in a clear and intelligible form; elaborate arrangements have been established for keeping the quality of the water under constant and expert supervision; and provision has been made by reservoirs, inter-communication mains, and other methods to secure that no part of the area shall suffer from a deficiency of supply."

In the light of the constitution of the Central Electricity Board, the B.B.C., and the London Passenger Transport Board, and having regard to the recent speech of Lord Reith in the House of Lords on the future control of public utilities, the question arises as to whether the composition of the Board is ideal for the administration of what is after all a gigantic business as well as a health service. There are no fewer than 66 members of the Board, appointed by the constituent authorities of the water area, the members holding office for three years, as follows:

London County Council, 14; Essex, Herts, Kent, Middlesex, and Surrey County Councils, one each (5); City of London and City of Westminster, two each (4); Metropolitan boroughs, one each (27); Lee Conservancy and Thames Conservancy, one each (2); 27 other boroughs and seven urban districts (of which seven have one representative each, the others being jointly represented by single members in groups of two to five areas) 14.

Apart from the possibility that the undertaking could be run just as efficiently by a board of half a dozen members possessing specialized skill or wide experience, the existing system is open to the objection that politics may influence the selection of any of the 66 representatives, not all of whom can in any case be said to possess special qualifications. Moreover, the "general election" of the entire Board once in three years opens up the possibility of a complete reversion of party colour just when some long term policy is in hand.

Statistics quoted in this article are taken from the British Waterworks Association's Directory and Annual Report, and from the *Municipal Year Book*, but the writer is solely responsible for the comments upon them.

INSTITUTION OF GAS ENGINEERS

AUTHORS' REPLIES TO DISCUSSION ON COMMUNICATION No. 248

Mr. E. V. EVANS

I should like to offer my thanks to those who have amplified the arguments developed in the Paper. Most particularly am I grateful to Professor Cobb and for the interest he continues to display in the research work of the Gas Industry. I am glad Professor Townend referred to the spirit of adventure, for indeed it is the spirit that the Industry will require if it is to discharge the responsibilities Mr. Forshaw stressed. Mr. Harman's remarks emphasize the extent of the field which is yet to be explored and developed. Mr. Pinkess has, I think, answered his own comment on the viewpoint of the business man. The Gas Research Board is concerned not to discourage scientists from remaining scientists, but is well aware that the existence of a large staff in impressive laboratories is not in itself an indication of good work.

To those who spoke on the urgency of the need for a bureau of information and data, I can give the assurance that this urgency is fully recognized by the Council, which regrets as much as anyone can the hindrances that the war has imposed.

Mr. E. CROWTHER

I wish first of all to express my thanks to those who have contributed to the Discussion upon the Paper, and not least for their criticisms, which will be very helpful when the time comes to translate into practice post-war projects at present in draft. In addition to divergent opinions upon matters of policy, which cannot fail to arise in the discussion of any controversial subject, two points of difficulty appear to have been encountered through a failure on my own part to make them sufficiently clear at the outset.

It should be understood in the first place that in every case the expression "all-gas" refers to heating and similar domestic services only, and that for such services as lighting, power, radio, &c., electricity would be expected to be used. The running costs quoted in the Appendices exclude these latter services.

In the second place, I should make it clear that the general designs of the houses selected as examples are those of actual properties in occupation locally. I have not attempted to express any opinion as to the merits of these designs, nor should it be assumed that they are such as I anticipate will be standard in post-war building. My purpose in using them as examples was to show how simply gas could be adapted to existing houses for their principal fuel-using services, whence by inference it presumably follows that gas will be equally adaptable and economical in post-war houses whatever may be their design. It is not my view that the Gas Industry should concern itself with the broad lines of domestic architecture, but should collaborate with the architect in the installation of the necessary fuel-using equipment as an integral part of the structure.

It is evident that the Gas Industry must make the fullest possible use in any such work of the advice of women specialists upon questions of equipment and particularly of its arrangement, as is well illustrated by Miss Godby's pertinent remarks.

I will not endeavour to discuss here the very interesting topics raised by Mr. Briggs (the communal provision of hot water and of steam-heating) and by Mr. Friedman (the relative merits of instantaneous and of storage hot-water systems), as either would provide matter for a Paper in itself.

Two remaining major points appear to emerge from the Discussion —the view held by several contributors as to the probability of the retention of the open (coal) fire, and the question (also raised in more than one quarter) as to how provision is to be made for the upkeep of equipment. As to the first, I suggest that we may see profound changes in the outlook of the "rising generation" after the war, when old customs may be discarded to an unexpected extent in favour of simplification of life. If this be so, the open fire may disappear at a surprising rate. As to upkeep, I believe that if the gas undertakings were relieved of the burden of original costs of the equipment, they would cheerfully face its maintenance and, in due time, its replacement, should this be necessary during the life of the building itself. The charge upon the gas supply so involved would not be of impossible magnitude given levels of consumption such as I have envisaged. Admittedly, the question is not altogether simple, and would repay detailed discussion should housing authorities be willing to entertain the inclusion of the prime cost in the cost of the fabric of the building.

Dr. E. A. C. CHAMBERLAIN

With reference to the question on the criterion of efficiency, it should be made clear that the "time factor" was purposely avoided and that efficiency expressed simply as—

$$\text{Efficiency} = \frac{\text{Total gas consumption.}}{\text{Quantity of work heat treated}}$$

does not therefore cover productive capacity. For existing equipment the time factor must be the responsibility of the production engineer, and even with new equipment production capacity is not the business of the industrial gas engineer unless he is asked for advice, as he frequently is.

With regard to hydrogen content in producer gas for stable flame conditions with modified town-gas burners, as the hydrogen content rises the flame stability increases as shown by the following figures:

TABLE A.—Maximum Gas Rates through Various Sizes of Gas Barrel which will give a Stable Flame without Lifting from the End of the Tube.

		Producer Gas.							
Barrel size, in.	Internal diameter in.	cu.ft. /hr.	2% H_2 ft./sec.	cu.ft. /hr.	7% H_2 ft./sec.	cu.ft. /hr.	12% H_2 ft./sec.	cu.ft. /hr.	15% H_2 ft./sec.
¾	0.813	95.0	7.0	225.0	16	550	40	990	71
½	0.625	70.4	9.0	190.0	24	415	53	595	76
⅜	0.5	38.6	8.0	74.0	15	225	46	385	78
¼	0.348	19.4	8.0	34.6	14	124	49	210	83
⅛	0.25	9.0	7.0	22.5	18	64	52	100	82
Mean rate, ft. per sec.			8		17		48		78

It is not possible to give a "suitable" figure for hydrogen content as the higher this is the better. The limiting value is imposed by the producer plant, its fuel, and its operation, but in general every effort should be made to ensure a hydrogen content of at least 10%.

(To be concluded)

MICROSCOPIC EXAMINATION OF SILICA REFRACTORIES*

By
P. F. F. CLEPHANE, M.Sc.,
Gas Light and Coke Company

THE raw material for the manufacture of silica refractories is quartz. When quartz is heat treated, its crystalline form changes and other varieties of silica, cristobalite and tridymite, develop, accompanied by an increase in volume. The prime considerations for the stability of a silica retort setting in service are the degree of conversion from quartz into cristobalite and/or tridymite which has been achieved in the kilning of the bricks, shapes, and segments, and the kind and proportion of bonding material used. These may be rapidly and accurately assessed by the use of a medium-power microscope, fitted with rotating stage, sub-stage condenser, polarizer, and analyzer.

The technique has been developed in principle by the geologist during a period of 140 years. Optical examinations were conducted initially upon loose grains, or crushed rock—the powder method, supplemented 50 years later in the case of rocks by the preparation of thin polished sections, which afford a better insight into the crystalline make-up of the solid. The cutting and polishing of such sections is a specialized undertaking, and so slow as to be of little value for routine test purposes in gas-works practice.

The powder method technique enables one to make an accurate estimation of refractive index, one of the most important of the optical properties used in the identification of transparent solids, and particularly valuable in the case of the various forms of silica. The details have been applied to routine control by A. Edwards, of the Gas Light & Coke Company, and we are indebted to him and to the Company for permission to publish this outline of the method and the benefits we think we have derived from it.

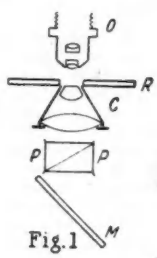


Fig. 1

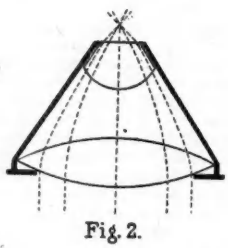
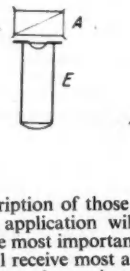


Fig. 2.



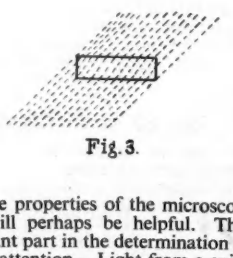


Fig. 3.

A brief description of those properties of the microscope germane to its present application will perhaps be helpful. The sub-stage condenser is the most important part in the determination of refractive indices and will receive most attention. Light from a suitable source is reflected from a plane mirror, M (fig. 1), through a nicol prism, or polarizer, P. (This may be kept in position throughout, although it is only essential when the identification of quartz or tridymite is in question.) The resultant polarized light passes into the condenser, C, which usually consists of a large short focus double-convex lens in combination with a smaller plano-convex lens, so arranged that all light entering the large lower aperture is concentrated into a converging beam brought to a focus in, or slightly above, the plane of the object under examination, which is mounted on a rotating platform, R. The object is thus viewed through the magnifying system, composed of the eyepiece, E, and the objective, O, in a much brighter light than would otherwise be possible. A second nicol prism, or analyzer, A, may be introduced in the optical path when necessary. When the axis of A is arranged at right angles to the axis of P no direct light is transmitted from the source.

For the determination of refractive index a transparent or translucent solid may be immersed in a liquid of known refractive index and observed by means of transmitted oblique illumination. A perfectly transparent crystal will visually disappear when the refractive indices of solid and liquid coincide. Crushed refractories are seldom pure enough to do this. It will be seen from fig. 2 that while as normally used the condenser produces symmetrical convergent illumination, approximately unilateral oblique illumination is obtained over one half of the field by cutting off half the lower aperture with an opaque screen. The other half of the field appears dark. Now consider the passage of light rays through the solid (in our case silica). If the medium has the lower refractive index, those rays entering the solid are deflected in their passage through it towards the normal, but resume their original inclination upon emergence (fig. 3). This results in a concentration of light at one edge of the solid and a reduction of light at the opposite edge, and gives rise to a sharply defined bright outline away from the dark part of the field and a corresponding dark outline towards it. If the medium has the higher refractive index, then light is deflected away from the normal and the relative positions of bright and dark outlines are reversed. With a sufficient range of media of known refractive index, it is thus possible to select one which gives a uniformly illuminated outline and therefore has the same refractive index as the solid. This determination of refractive index, taken in conjunction with the appearance of the specimen, is the means of assessing the adequacy of the heat treatment the refractory has received.

A 16 mm. objective gives the most satisfactory definition. Although it is not usually regarded as sound microscopic practice, in this particular application of the instrument we have found it preferable to increase magnification by means of the eyepiece, rather than the objective, when particle size is too small to show a clear outline with our normal combination of a 16 mm. objective and ×5 eyepiece.

Moulded Shapes

Silica refractories fall into two main classes, those bonded with lime and those bonded with clay.

In the process of manufacture of the lime-bonded type, milk of lime is added to crushed quartz rock, the proportion of lime to rock being about 2 to 98. By thorough mixing the lime is evenly distributed over the surfaces of the grains and forms a bond which keeps the moulded shapes together. In modern practice this is usually supplemented by the addition of an organic binder, sulphite cellulose lye, which increases the prefired strength of the shapes and reduces the risk of breakage in handling. It also serves to reduce the dust formed in the drying chambers and thereby operates against the development of silicosis in the workmen. There is considerable evidence that the actual strength of the fired products is improved by the initial incorporation of the organic binder. When, after drying, the shapes are kilned, the organic material burns out and the lime forms an extremely thin layer of calcium silicate glass over the silica particles and so helps to bond them firmly, but from the microscopic point of view it has disappeared, and cannot be detected. Thus, in subsequent examination of material of this type, nothing but silica is normally seen.

At normal kiln temperatures, quartz changes to cristobalite, another form of silica with a lower specific gravity and consequently greater volume per unit weight. For gas-works practice, where we expect our settings to stand up for from seven to ten years, it is desirable that the whole of this expansion should take place before the pieces are built in. Otherwise the retorts will continue to "grow" when they are put to work, with consequent damage to the structure as a whole. Moreover, quartz itself has a sharp inversion point at about 570°C. when it changes from its α to its β form, a change accompanied by a sudden expansion, liable to produce spalling and cracks. An additional reason for desiring complete conversion in the kiln is that it produces a stronger and less porous shape. As the grains expand they tend to move over one another, lubricated by the thin film of calcium silicate glass, and interlock, thus producing a stronger keyed bond and at the same time filling up part of the pore space left in the original moulding.

The method of preparing a specimen for examination is to scrub the surface free from foreign matter with a wire brush, particular care being taken to remove all loose grains of packing sand, which is used to separate the pieces in the kiln. This is normally a quartz sand, which resists conversion, and the accidental inclusion of any particles in the sample will give an entirely false idea of the conversion of the segment. A few grains are then scraped from the cleaned surface by running a chisel, or other suitable implement, over it. The sample obtained is ground in an agate mortar till the average grain size is approximately 0.01 mm. diameter. With a little experience it is possible to judge this fairly accurately from the colour of the powder. The refractive index is then determined in the manner previously outlined. The refractive index of quartz is 1.553 through one axis, and 1.544 through the other, giving an average value of 1.549. Cristobalite, the major constituent in a normal well converted shape, has a refractive index of 1.486. There is not a sharp change from quartz to cristobalite. It appears to be a gradual process and the

* Paper to the London and Southern District Junior Gas Association.

refractive index observed may have any value between the two forms of silica, when viewed in the particle size mentioned. A series of comparisons between the refractive index and the specific gravity has shown that the two properties are directly related. That is to say, silica with a refractive index midway between 1.549 and 1.486 has a specific gravity midway between that of quartz and cristobalite and is still capable of half the quartz expansion. Such a sample is, therefore, equivalent to half quartz and half cristobalite. Few manufacturers leave any unaltered quartz in their products designed for gas-works use, but it is seldom in these days of fuel economy that conversion is 100%. It therefore becomes necessary to make sure that conversion has gone far enough to reduce the possibility of permanent expansion in service to tolerable limits.

Assessing Equivalent Conversion

The method of assessing the equivalent conversion is to observe a series of fields immersed in liquids of arbitrarily chosen refractive index, commencing with the cristobalite value. We usually adopt 1.486, 1.493, 1.500, 1.510, and, if necessary, upward in steps of 0.010. The number of grains that lie above and below each value of R.I. are counted, and when a sufficient number have been noted (minimum of 200 for each group) the percentages falling between successive pairs of R.I. values are determined. For the purpose of calculating the equivalents of quartz and cristobalite, each portion is assumed to have the mean refractive index of its group. So long as not more than 13% of equivalent quartz remains, the material, in respect of after expansion, will come within the specification adopted by the I.G.E.

If any material is found with a refractive index between 1.52 and 1.55 it is usually a variety of quartz that is sluggish to convert, but it may be glass formed by local excess of bonding material or impurities in the original rock. This is decided by introducing the analyzer and again viewing the field. If no quartz is present the field will remain uniformly dark when the stage is rotated. Otherwise the quartz particles will light up and go out again as the stage is rotated, since quartz has the power of rotating polarized light. The small proportion of material sometimes observed with R.I. less than 1.486 may be tridymite (R.I. 1.472) or siliceous glass. In such instances the analyzer is again brought into play, when tridymite can be identified by the fact that, like quartz, it displays optical activity, though the amount of light transmitted is much less, and confirmed by its crystal shape.

It will be realized that this process, even after considerable experience, takes an appreciable time. Allowance has to be made for variations in grain size, so it is not a straight summation. It is not our practice to conduct a count on each individual specimen. If twenty are taken as representing a particular delivery, each individual is observed to see that there is no undue proportion of high refractive index material, and then a complete sample is prepared by mixing equal quantities of each and the count is made on that. The result so obtained represents the average conversion of the delivery.

In the case of clay-bonded silica material the position is rather more complex. It is difficult to draw a line at any given percentage of clay and say, with conviction, that on one side lie silica refractories, and on the other siliceous, but, in general, the less clay used the better. The system Al_2O_3–SiO_2 has a low melting eutectic mixture at about 7% of alumina. This means that with common quality fireclays, containing 33–35% alumina, 20% in a clay/quartz mix gives the right proportions for the least refractory product. With high-grade clays, containing 42–44% alumina, the same result is achieved with 16% of clay. It is obvious, then, that the higher the refractory quality of the bonding clay used, the less is permissible in silica shapes. While this is a theoretical truth, the realization may take years at retort temperatures, the duration depending on particle size and degree of heat work. It is nevertheless important to remember that where any clay meets silica the interface reaction necessarily involves the formation of the eutectic composition. Fluid layers are possible in a matter of hours, given the right heat work, assisted possibly by gas-borne inorganic elements.

A further consideration arises from the wide variation in ease of conversion and in the activity of different forms of quartz. The crushed gannister, or quartzite, rock most commonly used for refractory purposes converts to cristobalite with comparative ease. On the other hand, a second form of quartz, known as quartzose, and usually occurring in well-defined, rounded particles, is exceedingly sluggish in conversion, requiring a long time and a very high temperature. Where the former type of rock is used, the same considerations apply as for lime-bonded material, and the same qualities are required—viz., nearby complete conversion and the absence of any appreciable quantity of glass. With the latter a much higher proportion of clay is desirable and up to 10% permissible.

The quartz in such material remains substantially quartz throughout the life of the setting. The slight expansion which may occur due to partial conversion is offset by the slowness of the process and the slight contraction caused by the clay, which at working temperatures may reach the stage of a viscous fluid. The cracks which might develop due to the α–β quartz inversion, or other causes, during the putting up and letting down of settings are not a serious drawback, since they are sealed by the same viscous clay or its interaction product under gasmaking conditions. The inactivity of this particular form of quartz prevents any undue proportion of the silica itself from going into solution and a satisfactory life is obtained from this type of material in retort walls, though I have had no experience of its use in load-bearing positions at higher temperatures.

During microscopic examination care must be taken to differentiate partly converted quartz from glass, since the R.I. of the latter usually lies in the range 1.55–1.53, and may be lower. The optical activity of quartz down to R.I. 1.52 and the fissured appearance of the grain surface below that value are the distinguishing features. Glass, whatever its index, is always optically inactive and displays marked conchoidal fracture. If glass in excess of 5% is detectable the proportion is probably additional to surface wetting layers; the specimen should be viewed with suspicion and a refractoriness test carried out. Should any appreciable amount of unvitrified clay remain, it is distinguishable by its higher R.I. (usually above 1.56), and its opacity and optical inactivity. Its presence indicates underfiring and the probability of movement during service. Again the need for a refractoriness test is indicated.

Jointing Material

Silica jointing cements should consist of quartz plus the appropriate bonding material, irrespective of whether they are for use with lime-bonded or clay-bonded shapes. In good settings the joints seldom exceed $\frac{1}{8}$ in. in thickness, and in order to spread the layer evenly a much higher proportion of water has to be used than in the preparation of moulded pieces for kilning. Moreover, no pressure can be exerted to compact the jointing material in position. As a result the porosity of a joint can seldom be less than 35–40%. When built in, the pressure exerted by the weight of the settings is sufficient to coerce the subsequent expansion due to conversion of the quartz during service into the pore space, which is ample to accommodate it. Conversion thus makes the joints tighter as duration of service increases, and enables the grains to key together into a coherent whole.

A very brief examination under the microscope suffices to detect the presence of converted material or of an excessive amount of bonding agent, since the quartz will have a refractive index of 1.549 and be optically active. The second important consideration is grain size. The diameter of the largest particle should not exceed one quarter of the minimum joint thickness (*i.e.*, 0.8 mm.). While it is difficult to attain in practice, the aim for maximum joint density should be 60–70% of this order, and the remainder very much finer. For ease of working, however, the finer the grain size the better provided the batch has been milled, or at least well worked over, immediately before use. The grain size is very rapidly determined if the microscope is fitted with an eyepiece scale. A small sample spread on a slide can then be run through the field of view and the size limits read directly.

Order of Accuracy

The accuracy attainable in refractive index measurements is dependent on the use of monochromatic light. With a sodium vapour lamp this presents no difficulty, but where only white light is available a very close approximation to monochromatic light may be obtained by the use of a photographic filter, or combination of filters, to reduce the light band to narrow limits. The inexperienced operator can then detect a difference of 0.003 in refractive index, and, after a little experience, differences of 0.001 are quite plain. The difference between quartz and cristobalite is 0.063, so that results within 2% may be expected. Comparison between results obtained by the microscopic method and by specific gravity determination have demonstrated that the variation between the two seldom exceeds 3% and never exceeds 5% if due care and attention are paid to both operations. Thus, if 10% of quartz is found, the true value will lie between 9.5% and 10.5%.

We were in some doubt at first as to the reliability of surface scratchings, but a wide survey of the field of silica refractories has shown that the degree of conversion throughout all normal sized shapes is uniform. The relatively high heat conductivity of silica, coupled with the slow rate of heating and long duration of kiln treatment used in manufacture, ensures that the heat work to which the centre is subjected is substantially the same as for the outer surfaces. It is thus possible to study a really representative number of specimens from any consignment without damaging them for subsequent use—a virtue possessed by no other method of examination so far advanced. It must be borne in mind, however, that while it is safe to pass material that gives a satisfactory showing on microscopic examination, where purchase is made under contract based on I.G.E. specifications, doubtful specimens must be submitted to further tests before rejection. In the case of our own Company the purchase contract includes a clause:

"The Company will submit the silica material to microscopic examination as evidence of the degree of conversion of quartz necessary to comply with the after expansion requirements of the I.G.E. Specification. Should such observations indicate that the material would fail to comply with the I.G.E. Specification, the degree to which it is judged to fail shall be accepted by the contractor."

The order of accuracy indicated refers, of course, to the specimens

actually examined. That relative to the whole consignment will vary with the magnitude of the variation from the mean, upon which the number of increments to be taken will depend. It is impossible here to enter into a discussion of the increments required for any desired order of accuracy. To develop the theory of sampling would require a very long Paper in itself, but those who are interested may be referred to a publication, No. 600–1935, by the B.S.I. "The Application of Statistical Methods to Industrial Standardization and Quality Control," where the matter is discussed at length from a variety of angles.

Refractive Index Media

The preparation of a wide range of liquid media is not difficult. Fortunately, the refractive index of miscible liquids is an additive property. That is, if equal volumes of two liquids mix without volume change or chemical action, the refractive index of the mixture is half the sum of the refractive indices of its components. There are two pairs of liquids, recommended by an American source, which cover the range of most solid substances commonly met.

They are:

Ethylpropionate	R.I. 1.3841 at 20°C.	Vapour pressure	27.75 mm. at 20°C.
Mesitylene	R.I. 1.4981	,,	,,	,,	27.15 ,,
Butylphthalate	R.I. 1.4932	,,	,,	,,	3.8 mm. at 110°C.
Bromonaphthalene	R.I. 1.6582	,,	,,	,,	3.5 ,,

The vapour pressures of the constituent members of each pair are approximately the same, so that wandering from the initial R.I. of the mixture due to differential evaporation is avoided. This can be a serious source of error if media are chosen without due regard to this property.

Available mixtures that have been tried out at Beckton and proved satisfactory are:

1.	For R.I. range:	1.410–1.442	Ethyl Oxalate and Nitrobenzene.
2.	,,	1.442–1.493	Ethyl Citrate and *n* Butylphthalate.
3.	,,	1.493–1.658	*n* Butylphthalate and α Bromonaphthalene.
4.	,,	1.658–1.747	α Bromonaphthalene and Methylene Iodide.
5.	,,	1.747–1.783	Solutions of Sulphur in Methylene Iodide.

If there is no access to a refractometer, the true R.I. of the prepared mixture (except in the case of group (5) above) can be calculated from the known R.I. of the constituents and the proportion in which they are mixed. But this implies extremely accurate mensuration, and it is quicker to make up approximately correct mixtures and then determine their true R.I. The Leitz-Jelly Refractometer (described by Dr. E. E. Jelly in the *Journal of the Royal Microscopical Society*, 1934, **54**, 234–5) is a most suitable instrument for the purpose. Individual determinations take a matter of seconds, and require no more than 0.001 ml. of liquid. The accuracy of the instrument depends upon its initial calibration, but so far as our own is concerned, it is in complete agreement to the third decimal place with the Abbe refractometer, usually regarded as a standard instrument, over the whole range of the latter. The range of R.I. media given here is wider than that required for silica refractories, but once the method is inaugurated it will be found that there are many other occasions when the determination of refractive index is valuable in the rapid identification of materials brought into the laboratory for investigation.

Simpler Gas Meters

A patent aiming at the simplification of dry gas meters has been taken out by Parkinson & Cowan (Gas Meters), Ltd., L. H. Rolfe, and R. R. R. Douglas. The patent (No. 544,752, application date, Dec. 14, 1940) has for its object to provide an improved construction of meter with reduced overall dimensions, particularly from front to back, simplicity of manufacture, and reduced pressure loss. It comprises a dry gas meter having two vertically disposed diaphragms arranged side by side with each diaphragm double acting or delivering gas from both its sides. It also comprises locating the transfer valves immediately above the diaphragm compartments, and the operation of the transfer valve by a single throw crank through slotted arms or levers which may constitute, with the valves or their actuating arms, bell crank levers—the slotted arms having an angle between them which gives the desired timing of valve and diaphragm movements.

Fig. 1 is a sectional elevation substantially on the line AB of fig. 2 and 3, showing a dry gas meter constructed in one convenient form in accordance with the invention. Fig. 2 is a plan view of the valve chamber or top portion of the meter with the cover removed, while fig. 3 is a sectional end view on the line CD of fig. 1.

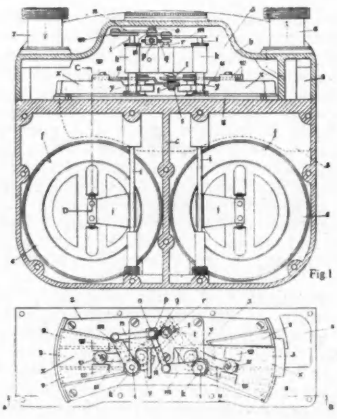


Fig. 1

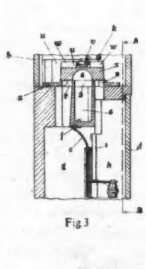


Fig. 3

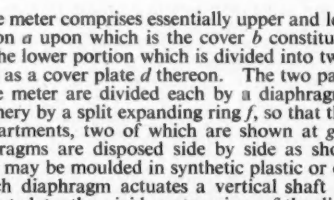


Fig. 2

The meter comprises essentially upper and lower portions, the upper portion *a* upon which is the cover *b* constituting the valve chamber, and the lower portion which is divided into two parts by the partition *c* and as a cover plate *d* thereon. The two parts of the lower portion of the meter are divided each by a diaphragm *e* held in place at its periphery by a split expanding ring *f*, so that there are four diaphragm compartments, two of which are shown at *g* and *h* in fig. 3. The diaphragms are disposed side by side as shown. The body of the meter may be moulded in synthetic plastic or die cast.

Each diaphragm actuates a vertical shaft *i* by an arm *j* pivotally connected to the rigid centre-piece of the diaphragm. Each shaft *i* projects into the top or valve chamber of the meter through a stuffing box *k*, and carries at its top an arm *m* which is oscillated back and forth due to the movements of the diaphragm to which its shaft is coupled. Each arm *m* is coupled by a link *n* and pivot pin *o* to a block *p* on a crank arm *q* which rotates a crank shaft *r*. The cranked lower end *s* of the shaft has two rollers, *t*, *t* thereon, each of which moves in the bifurcated or slotted arm of a bell crank lever *u*, the other arm of which carries an eccentric *v* which comes between two lugs *w* on the transfer valve *x*. Each of the two valves *x* turns about a fulcrum pin *y* which is also the fulcrum pin of the bell crank lever *u*. The eccentrics *v* permit of accurate setting of the valves with reference to the crank *s* by which they are oscillated over the transfer ports.

The slotted arms of the bell crank levers *u* form an angle of 90° with each other in their mean positions in order to give the desired valve timing. The valves may be at 180° to each other, or to any other desired angle.

A valve seating plate *z* forming both valve seats and sealing an exhaust conduit 5 from the valve chamber may be die cast in one piece and provides the four inlet ports 2 and two exhaust ports 3, the transfer of the gas from the inlet to the exhaust being effected by the arched passage 4 the valve *x* in the usual manner. The exhaust ports 3 in the valve plate lead to the conduit 5 which may be formed within the lower portion of the meter, the conduit terminating at the right-hand side of the lower portion of the meter as shown in Fig. 2, beneath the gas outlet pipe 6 in the meter cover *b*. The latter, which may be made of moulded plastic or be a die casting, covers the valve mechanism and forms the gas inlet chamber *c* of the meter which receives gas from the inlet branch 7. It also forms a gas outlet chamber 8 which comes over the right-hand end of the conduit 5 and has the outlet branch 6 leading therefrom.

An inspection cover is provided on the top of the cover *b*, this cover giving ready access to the mechanism in the gas chamber for inspection and adjustment purposes.

The transfer valves *x* and the four ports 2 are directly over the diaphragm compartments *g* and *h*, thereby eliminating capacity losses such as usually occur due to the flow of the gas through tubes and round bends and corners. The arrangement also permits of the arms *j* moving through equi-angular distances on each side of a mid-position when the diaphragms are also in a mid position with the arms parallel thereto. In like manner the links *n* when at the beginning and end of their movements are in the same straight line passing through the axis of the crank shaft *r* which facilitates accurate valve timing and increases the efficiency of the meter. These features make for a lower pressure absorption and/or a larger gas throughput.

The transfer valves may if desired be of the straight slide type instead of the arc or radial type as shown.

Copies of British Standards 1016–1942, "British Standard Methods for the Analysis and Testing of Coal and Coke," and 1017–1942, "British Standard Methods for the Sampling of Coal and Coke," may be obtained, price 2s. each, from the Secretary of The Institution of Gas Engineers, 1, Grosvenor Place, S.W. 1. Also War Emergency British Standard 1033–1942, "Priming Paint and Lead Base for the Protection of Steel Sheet."

Presiding over the annual general meeting of the Northampton Gaslight Company in the absence through illness of the Chairman, Col. G. S. Eunson said the gas consumption since the appeal of the Government for economy had shown that the public were responding well so far as gas was concerned. The past year had been a satisfactory one for the Company despite the inevitable difficulties imposed by the war, and the absence of ninety members of the staff now serving in H.M. Forces.

Gas Products Prices

The London Market Aug. 17.

The only change in the prices of Coal Tar Products in the London Market refers to 95/160 Solvent Naphtha, which is now about 2s. 3d. to 2s. 7d. per gallon.

The Provinces Aug. 17.

The average prices of gas-works products during the week were: Pitch and Crude Tar,* Toluole, naked, North, 90's, 1s. 10d., pure, 2s. 5d. (controlled by the Control of Toluene No. 2 Order, July 3, 1941, which fixes the maximum price at which this material may be sold). Coal tar, crude naphtha, in bulk, North, 1s. to 1s. 4d. according to quality. Solvent naphtha, naked, North, 2s. 2d. to 2s. 6d. Heavy naphtha, North, 1s. 10d. to 1s. 11d. Carbolic acid, 60's, controlled by the Coal Tar Acids Prices (Inland) Order, 1942, operative from May 1. Naphthalene, controlled by the Naphthalene prices (Inland) Order, 1942, dated April 15, 1942, and operative from May 1, 1942, £19 to £19 10s.—bags free. Anthracene, controlled by the Anthracene Prices (Inland) Order, 1942, operative from May 1. Filtered heavy oil (min. gr. 1,080), 7¼d. to 8d. Creosote oil has been generally controlled as to direction and price for some time past. Current value—fuel grades 5d. to 5½d; timber preservation and other purposes 4⅜d. to 6d. These prices apply as from May 13.

*In regard to pitch and crude tar prices we would ask readers to refer to the editorial note on p. 396 of the "JOURNAL" for Sept. 10, 1941.

Tar Products in Scotland Aug. 15.

Throughput continues satisfactory. Refined tar controlled. Value about 4½d. per gallon *ex* Works naked. Creosote oil: Specification oil, 6¾d. to 7d.; low gravity, 7¼d. to 7½d.; neutral oil, 6¾d. to 7d. per gallon; all *ex* Works in bulk. Cresylic acid is in good call at 3s. 6d. to 4s. 6d. per gallon *ex* Works, naked, according to quality. Crude naphtha 6½d. to 7d. Solvent naphtha: 90/160 grade, 2s. to 2s. 3d., and 90/190 Heavy Naphtha 1s. 9d. to 2s. per gallon. Pyridine: 90/160 grade, 13s., and 90/140 grade, 15s. per gallon.

Gas Stocks and Shares

Stock markets finished the week with a bright tone. Although the turnover was small industrials attracted the most attention, but gilt-edged and home rails made a good showing. The volume of business in the Gas Market was about normal and prices generally were well maintained. It will be noticed that in the Official List Bournemouth 7% and Croydon sliding scale stocks recorded sharp rises, business being recorded at 138½ (against the last transaction at 129) and 112¾ (against 101) respectively. The price of the Oriental Stock was adversely affected by the latest news from India, but this will doubtless speedily recover on the resumption of normal activities. In the Supplementary List the prices of transactions in Liverpool ordinary fluctuated during the week, the last transaction at 105 causing a marking down of 5 points. There were no changes in the Supplementary List.

The following quotations were changed during the week:

OFFICIAL LIST

Bournemouth 7 p.c. max.	135—140	+10
Croydon Sliding Scale	108—113	+11
Imperial Continental	62—67	—1
Oriental Ord.	80—90	—5
Wandsworth Ord. (*x.d.*)	80—85	Aug. 10
Ditto 4 p.c. Pref. (*x.d.*) ...	77—82	"
Watford & St. Albans Ord. (*x.d.*) ...	98—103	"

PROVINCIAL EXCHANGES

Chester Ord. (*x.d.*)	96—99	Aug. 4
Liverpool	104—106	—5
Newcastle Units (*x.d.*)	20/—20/6	Aug.
Ditto 4 p.c. Pref. (*x.d.*)	92½—93½	"
Weston-Super-Mare 4 p.c. Deb. ...	84—89	—1
Ditto 7½ p.c. Deb.	140—145	+2

TRADE CARDS

FULL particulars of these spaces can be obtained on application to the Publishers. They are designed principally for the use of the firms whose display advertisements cannot be included owing to paper rationing.

TOM CARRINGTON & CO. LTD.
Lyndon Toolworks, West Bromwich. T/N 0517 (2 lines).
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51, High Street, Esher, Surrey. T/N Esher 1142.
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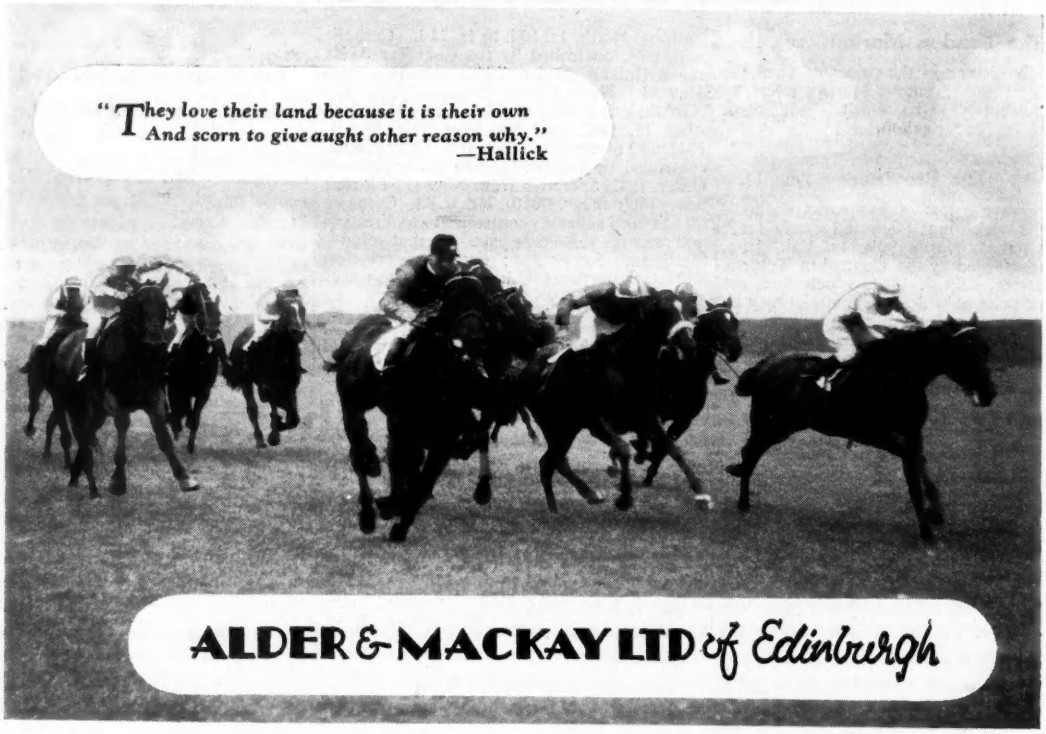
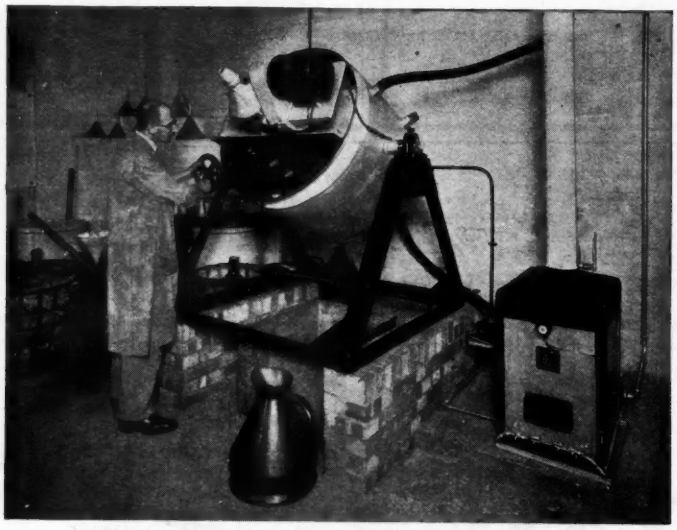

"They love their land because it is their own
And scorn to give aught other reason why."
—Hallick
ALDER & MACKAY LTD of Edinburgh

"REX" Gas-fired Boilers for RESEARCH



"REX" Boiler with flexible connection to a jacketed pan.

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The illustration shows an unusual example where flexibility is greatly pronounced.

The duty of the "REX" Gas Water Heater in this case is to heat the jacket of a pan used for liquifying certain substances.

The temperature of circulation is 180° F., and the couplings are so arranged that the pan can be tipped to an angle of 90° in order to pour off the liquid when required.

The tipping mechanism is by bevelled gear, and the couplings between the boiler and the jacket are made with heavy steam quality rubber and arranged in such a way that at all times circulation is maintained with automatic air release.

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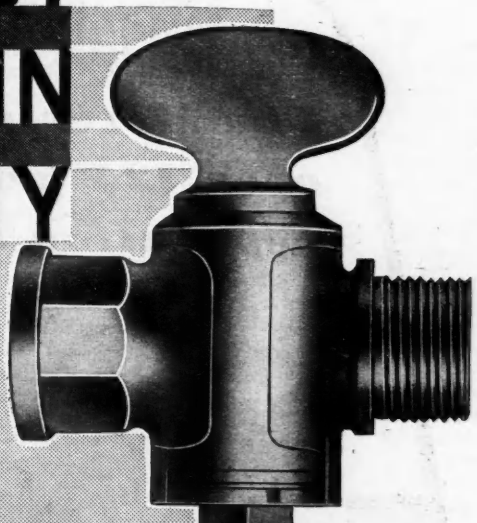
THE FOREMOST GAS COCK IN THE INDUSTRY



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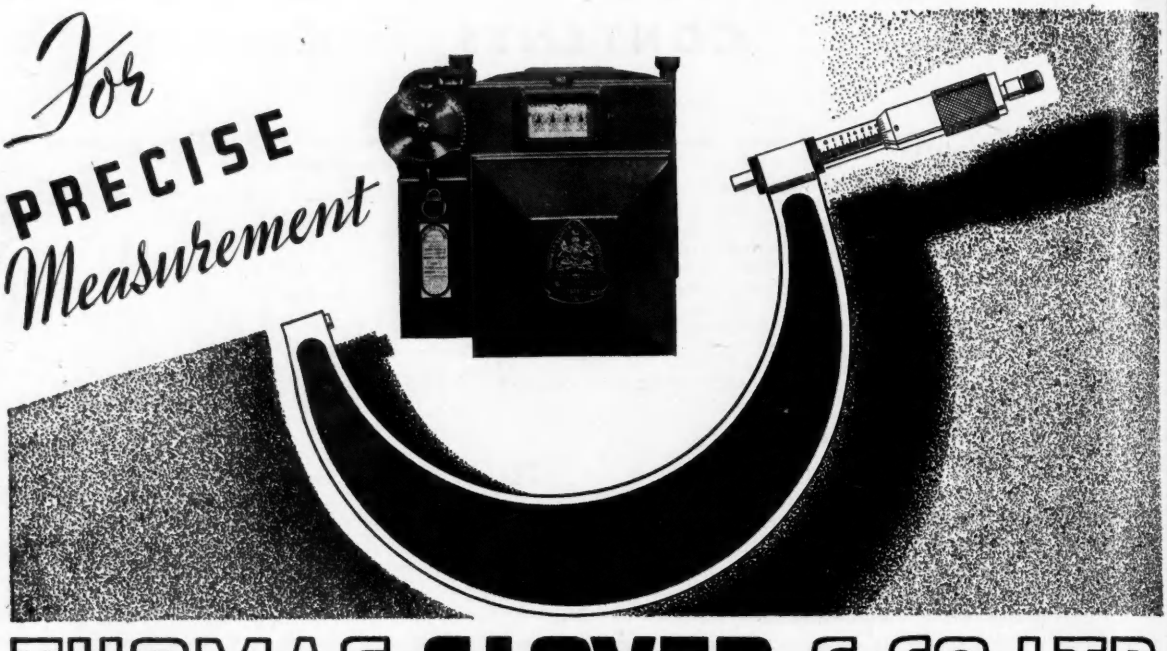

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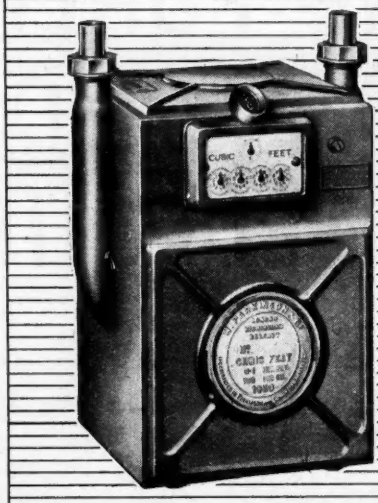

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